LORD JOHN MANNERS stated in the House of Commons on Thursday last that experiments have been made by officers of the Post-Office with the telephone, the result being that the instrument is not at present considered suitable for public telegraphy.

IN Prof. Lebour's letter on Marine Fossils in the Gannister Beds of Northumberland, in last week's NATURE, the word *country* should have been *county*. It is the first time marine forms have been found in this series in Northumberland.

THE additions to the Zoological Society's Gardens during the pas week include two Black-winged Pea-Fowls (*Pavo nigripennis*) from Cochin China, presented by the Hon. A. S. G. Canning, F.Z.S.; a Javan Parrakeet (*Palæornis javanica*) from Muttra, North-West India, presented by Mr. Barthorp; two Red-vented Bulbuls (*Pycnonotus hæmorrhous*) from India, presented by Col. A. L. Annerley, F.Z.S.; two Leopards (*Felis pardus*) from Persia, deposited; two Barbary Wild Sheep (*Ovis tragelaphus*) from North Africa; two Pale-headed Parrakeets (*Platycercus pallidiceps*) from North-East Australia; four Turquoisine Parrakeets (*Euphema pulchella*) from New South Wales, pu chased; two Tigers (*Felis tigris*), born in the Gardens.

ON COMPASS ADJUSTMENT IN IRON SHIPS [1]

II.

AN important objection was made to me some years ago by Capt. Evans against the use of quadrantal correctors in the Navy, that they would prevent the taking of bearings by the prismatic azimuth arrangement, which forms part of the Admiralty standard compass. The azimuth mirror (Fig. 5) applied to the compass before you was designed to obviate that objection. Its use even for taking bearings of objects on the horizon is not interfered with by the globes constituting the quadrantal correctors, even if their highest points rise as high as five inches above the glass of the compass-bowl. It is founded on the principal of the camera lucida. The observer when taking a bearing turns the instrument round its vertical axis until the mirror and lens are fairly opposite to the object. He then looks through the lens at the degree divisions of the compass-card, and turns the mirror round its horizontal axis till he brings the image of the object to fall on the card. He then reads directly on the card the compass bearing of the object. Besides fulfilling the purpose for which it was originally designed, to allow bearings to be taken without impediment from the quadrantal correctors, the azimuth mirror has a great advantage in not requiring any adjustment of the instrument, such as that by which, in the prism compass the hair is brought to exactly cover the object. The focal length of the lens in the azimuth mirror is about 12 per cent. longer than the radius of the circle of the compass-card, and thus, by an elementary optical principle, it follows that two objects a degree asunder on the horizon will, by their images seen in the azimuth mirror, cover a space of $1^{\circ}\cdot12$ of the divided circle of the compass-card seen through the lens. Hence, turning the azimuth instrument round its vertical axis through one degree will only alter the apparent bearing of an object on the horizon by $\cdot12^{\circ}$. Thus it is not necessary to adjust it exactly to the direct position for the bearing of any particular object. If it be designedly put even as much as 4° awry on either side of the direct position, the error on the bearing would hardly amount to half a degree. If the instrument were to be used solely for taking bearings of objects on the horizon, the focal length of the lens should be made exactly equal to the radius of the circle, and thus even the small error of $\cdot12^{\circ}$ in the bearing for one degree of error in the setting would be avoided. But one of the most important uses of the azimuth instrument at sea is to correct the compass by bearings of sun or stars at altitudes of from 0° to 50° or 60° above the horizon. The actual focal length is chosen to suit an altitude of 27°, or thereabouts (this being the angle whose natural secant is $1\cdot12$). Thus if two objects whose altitudes are 27°, or thereabouts, and difference of azimuths 1°, are taken simultaneously in the azimuth mirror, their difference of bearings will be shown as one degree by the divided circle of the compass-card seen through the lens. Hence for taking the azimuth of star or sun at an altitude of 27°, or thereabouts, no setting of the azimuth mirror by turning round the vertical axis is necessary, except just to bring the object into the field of view, when its bearing will immediately be seen accurately shown on the divided circle of the compass-card. This is a very valuable quality for use in rough weather at sea, or when there are flying clouds which just allow a glimpse of the object, whether sun or star, to be caught, without allowing time to perform an adjustment, such as that of bringing the hair, or rather the estimated middle of the space traversed by the hair in the rolling of the ship, to coincide with the object. The same degree of error as on the horizon, but in the opposite direction, is produced by imperfect setting round the vertical axis in taking the bearing of an object at an elevation of 38°.

Thus for objects from the horizon up to 38° of altitude the error in the bearing is less than 12 per cent. of the error of the setting. For objects at a higher elevation than 38° the error rapidly increases; but even at 60° altitude the error on the bearing is a little less than half the error of the setting; and it is always easy, if desired, to make the error of the setting less than

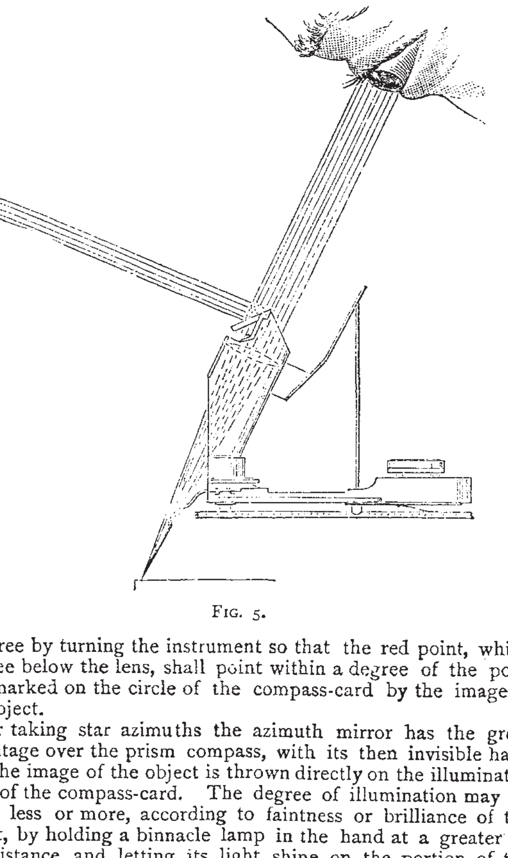

FIG. 5.

a degree by turning the instrument so that the red point, which you see below the lens, shall point within a degree of the position marked on the circle of the compass-card by the image of the object.

For taking star azimuths the azimuth mirror has the great advantage over the prism compass, with its then invisible hair, that the image of the object is thrown directly on the illuminated scale of the compass-card. The degree of illumination may be made less or more, according to faintness or brilliance of the object, by holding a binnacle lamp in the hand at a greater or less distance, and letting its light shine on the portion of the compass-card circle seen through the lens. Indeed, with the azimuth mirror it is easier to take the bearing of a moderately bright star by night than of the sun by day: the star is seen as a fine point on the degree division, or between two, and it is easy to read of its position instantly by estimation to the tenth of a degree. The easiest, as well as the most accurate of all, however, is the sun when bright enough and high enough above the horizon to give a good shadow on the compass-card. For this purpose is the stout silk thread which you see, attached to the framework of the azimuth mirror in such a position that when the instrument is properly placed on the glass of the compass-bowl, the thread is perpendicular to the glass and through the central bearing-point of the compass.

Another advantage of the azimuth mirror particularly important for taking bearings at sea when there is much motion, is

[1] Report of paper read to the Royal United Service Institution, February 4, by Sir Wm. Thomson, LL.D., F.R.S., P.R.S.E., Professor of Natural Philosophy in the University of Glasgow, and Fellow of St. Peter's College, Cambridge. Revised by the Author. [The Council of the R.U.S.I. have kindly permitted us to publish Sir W. Thomson's paper in advance, and have granted us the use of the illustrations.—ED.] Continued from p. 334.

that with it it is not necessary to look through a small aperture in an instrument moving with the compass-bowl, as in the ordinary prism compass, or in the original nautical azimuth compass (described 280 years ago by Gilbert, Physician in Ordinary to Queen Elizabeth, in his great Latin book. "On the Magnet and on the Earth a great Magnet"), which is very much the same as that still in use in many of the best merchant steamers. In using the azimuth mirror the eye may be placed at any distance, of from an inch or two to two or three feet, from the compass, according to convenience, and in any position, and may be moved about freely through a considerable range on either side of the line of direct vision through the lens, without at all disturbing the accuracy of the observation. This last condition is secured by the lens being fixed in such a position of the instrument that the divided circle of the compass-card is in its principal focus. Thus the virtual image of the divided circle is at an infinite distance, and the images of distant objects seen coincidently with it by reflection in the plane mirror show no shifting on it, that is to say, no parallax, when the eye is moved from the central line to either side. From the geometrical and optical principles explained previously, it follows also that if the azimuth instrument be used for taking the bearing of an object whose altitude is less than 27°, then the effect of turning the frame carrying the lens and mirror in either direction will seem to carry the object in the same direction relatively to the degrees of the card; or in the contrary direction if the altitude exceeds 27°. But if the altitude of the object be just 27°, then the azimuth instrument may be turned through many degrees on either side of the compass-card, without sensibly altering the apparent positions of the objects on the degree-divisions.

II.—*An Adjustable Deflector for completely determining the Compass Error when Sights of Heavenly Bodies or Compass Marks on Shore are not available.*

About thirty years ago Sir Edward Sabine gave a method in which, by aid of deflecting magnets properly placed on projecting arms attached to the prism circle of the Admiralty standard compass, a partial determination of the error of the compass could be performed at any time, whether at sea or in harbour, without the aid of sights of heavenly bodies or compass marks on shore. The adjustable magnetic deflector before you is designed for carrying out in practice Sabine's method more rapidly and more accurately, and for extending it, by aid of Archibald Smith's theory, to the complete determination of the compass error, with the exception of the constant term "A" of the Admiralty notation, which in almost every practical case is zero, and can only have a sensible value in virtue of some very marked want of symmetry of the iron work in the neighbourhood of the compass.[1] When it exists it can easily be determined once for all and allowed for as if it were an index error of the compass card, and it will, therefore, to avoid circumlocutions in the statements which follow, be either supposed to be zero or allowed for as index error.

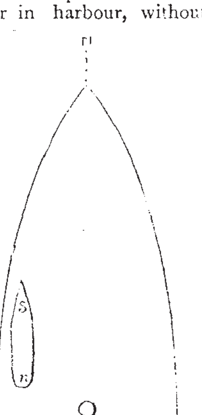

Fig 6.

[1] I had a curious case lately of the effect of unsymmetrical iron on a midship steering compass, due to a steam-launch about thirty feet long placed fore-and-aft on the port side of the deck with its bow forward and its stern five or six feet before the thwart-ship line through the position of the compass. Adjustment having been performed by means of the globes and magnetic correctors to correct the quadrantal error (D), and the semicircular error, it was found (as was expected) that the compass was correct on the east and west points, but showed equal westerly errors of about $3\frac{1}{2}$° on the north and south points. There were, therefore, approximately equal negative values of "A" and "E" each $1\frac{3}{4}$°. The captain was, of course, warned of the change he would find when he was relieved of the steam-launch at Rangoon, the port of his destination. The explanation of the westerly deviation when the ship's head was north or south, by the inductive magnetism of the steam-launch, according to which its stern would be a true north pole when the ship is on the north course, and a true south pole when the ship is on the south course, is obvious from the annexed diagram, in which the letters *n*, *s*, denote true north pole and true south pole of induced magnetism in the steam-launch when the ship's head is north magnetic.

The new method is founded on the following four principles:—

1. If the directive force on the compass needles be constant on all courses of the ship, the compass is correct on all courses.
2. If the directive force be equal on five different courses, it will be equal on all courses.
3. Supposing the compass to be so nearly correct or to have been so far approximately adjusted, that there is not more than eight or ten degrees of error on any course, let the directive forces be measured on two opposite courses. If these forces are equal the compass is free from semicircular error on the two courses at right angles to those on which the forces were measured; if they are unequal there is a semicircular error on the courses at right angles to those on which the forces were measured, amounting to the same fraction of the radian (57·3°) that the difference of the measured forces is of their sum.
4. The difference of the sums of the directive forces on opposite courses in two lines at right angles to one another, divided by the sum of the four forces, is equal to the proportion which the quadrantal error, on the courses 45° from those on which the observations were made, bears to 57·3°.

The deflector may be used either under way or in swinging the ship at buoys. The whole process of correcting the compass by it is performed with the greatest ease and rapidity when under way with sea room enough to steer steadily on each course for a few minutes, and to turn rapidly from one course to another. For each operation the ship must be kept on one course for three or four minutes, if under way, by steering by aid of an auxiliary compass, otherwise by hawsers in the usual manner if swinging at buoys, or by means of steam-tugs. A variation of two or three degrees in the course during the operation will not make a third of a degree of error in the result as regards the final correction of the compass. The deflector reading is to be taken according to the detailed directions in sections 14 and 15 of the printed "Instructions." This reading may be taken direct on the small straight scale in the lower part of the instrument. The divided micrometer circle at the top is scarcely needed, as it is easy to estimate the direct reading on the straight scale to a tenth of a division, which is far more than accurate enough for all practical purposes. This reading with a proper constant added gives, in each case, the number measuring in arbitrary units the magnitude of the direct force on the compass for the particular course of the ship on which the observation is made.

The adjustment by aid of the deflector is quite as accurate as it can be by aid of compass marks or sights of sun or stars, though on a clear day at any time when the sun's altitude is less than 40°, or on any clear night, the adjuster will of course take advantage of sights of sun or stars, whether he helps himself also with the deflector or not.

III.—*New Form of Marine Dipping Needle for facilitating the Correction of the Heeling Error.*

This instrument is designed as a substitute for the vibrating vertical needle, hitherto in use for carrying out the observations of vertical force, whether on board ship or on shore, required for performing the operations described in Part iii. Section 4, and the last three pages of Part iv. of the Admiralty Manual. It consists of a light bar-magnet or "needle" of hardened steel wire, supported by means of a very small aluminium cradle on a stretched platinum wire, of which the two straight parts on the two sides of the needle are, as nearly as may be, in a line through its centre of gravity. One flat end of the needle is painted white, with a black line through its middle parallel to the platinum wire. When the instrument is properly placed for use the platinum wire is horizontal, and the needle is brought into a horizontal position by turning one end of the platinum wire until the elastic force of the torsion balances the turning motive (or "couple") due to the vertical component of the magnetic force of the locality. A divided circle is used (as the torsion head of the original Coulomb's Torsion Balance) to measure the degrees of torsion to which, according to Coulomb's original discovery, the turning motive is proportional. Thus, the magnetic moment of the needle being constant, the vertical component of the magnetic force in the locality of the observation is measured simply in degrees or divisions of the torsion head. A glass plate, fixed in a vertical position parallel to the platinum wire and close to the painted end of the needle, has a horizontal score across it on the

level of the platinum wire. By aid of a totally reflecting prism, like that of the prismatic azimuth compass, with one side convex, the user of the instrument looking downwards sees when the black line on the end of the needle is exactly level with the score on the glass plate. This mode of sighting has proved very satisfactory; it is very easily and quickly used, and it is so sensitive that with the dimensions and magnetic power of the instrument before you it shows easily a variation of vertical force amounting to $\frac{1}{100}$ of the earth's vertical force in this locality. The accompanying printed instructions for the adjustment of my compass describe in sufficient detail the way of using it for correcting the heeling error.

In the instrument before you there is a divided paper circle in the bottom of the box to serve as a "dumb card," to be used with the azimuth mirror when there may be occasion for the use of a non-magnetic azimuth instrument. This appliance has nothing to do with the dipping needle, and is introduced because, while adding little or nothing to the cumbrousness of the instrument, it saves the adjuster the necessity for carrying a separate azimuth instrument with him.

(To be continued.)

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

OXFORD.—From the University Calendar for 1878 we learn that the Undergraduates, who were last year 2,590, have now risen to 2,659, while the members of Convocation have increased from 4,870 to 5,026. During the year 320 have taken the degree of Master of Arts, and 446 that of Bachelor of Arts. The number of matriculations, which in 1868 was 579, and which in 1876 was 650, rose in 1877 to 770. But this increase was due to the number of candidates for a musical degree. The list of members of Congregation—that is, of the legislative body of resident members of Convocation—has increased, but only slightly. In 1876 they numbered 314; in 1877, 322. But the proportion between clergymen and laymen has considerably changed during the year. In 1876 there were 180 clergymen and 134 laymen; in 1877 the laymen have risen to 154, and the clergymen have fallen to 168. Of the whole body of Fellows (exclusive of Christ Church), resident and non-resident, there are at present 192 laymen and 116 clergymen.

CAMBRIDGE.—The Council of the Senate having had under consideration a letter from Prof. Hughes, Woodwardian Professor of Geology, representing the need for additional assistance, propose that an assistant be appointed, with a stipend of 200*l.* per annum, whose duties shall be to assist the Professor in the arrangement and care of the geological collections, to give such instruction and demonstrations as may be required, and to assist students making use of the museum. It is proposed to vest the appointment in the Professor, with the consent of the Vice-Chancellor.

EDINBURGH.—A site has been secured in Chambers Street, close by the University, for the erection of a new school of medicine for extra-academical teachers, on the spot formerly occupied by Minto House, so long the scene of the demonstrations and prelections of eminent extra-mural lecturers.

TAUNTON COLLEGE SCHOOL.—A microscopic cabinet by Smith and Beck, with other valuable apparatus, has been presented to the Rev. W. Tuckwell by his late assistant-masters at the Taunton College School, as an expression of their personal sympathy and their recognition of the services rendered by him to the higher education.

PRUSSIA.—January 20 was a red letter day for a number of professors in Prussian universities, no less than fifteen receiving orders of different ranks from the Emperor William.

DRESDEN.—On May 1 the Royal Polytechnic Institution at Dresden will celebrate the fiftieth anniversary of its foundation. Originally confined to the narrowest limits, the Institution has rapidly developed, and is now one of the most frequented polytechnic schools of Germany.

GREIFSWALD.—The attendance on the university shows a decrease as compared with the past summer. The students number 43 in the theological faculty, 73 in the legal, 126 in the philosophical, and 218 in the medical. The corps of professors and privat-docenten is at present 60. A library of 60,000 volumes, well equipped laboratories and collections, and ample revenues place Greifswald on a par with most German universities, but for a number of years it has failed singularly to compete in point of attendance with many poorer centres of study.

TÜBINGEN.—The university shows at present the highest winter attendance since its foundation. The students are divided as follows: Theology (evangelical), 215, (catholic), 108; law, 256; natural sciences and medicine, 222; philosophy, 145.

MÜNSTER.—Prof. R. Sturm, of the Darmstadt Polytechnic, has been appointed to the chair of mathematics, rendered vacant by the late death of Prof. Heis. The number of students at present is 312.

BERLIN.—Prof. Schwedener, of Tübingen, has received a call to Berlin to fill the second professorship for Botany lately created at the University.

VIENNA.—In the lately presented educational budget of Austria the sum of 50,000*l.* is appropriated for the erection of new buildings for the Vienna University.

DORPAT.—The hitherto rigorous rule of Russian universities requiring from all instructors the possession of Russian diplomas of the doctorate, &c., has been modified in the case of Dorpat, recognition being made of foreign degrees and professorial positions.

SIBERIA.—The Imperial Commission appointed to settle the long-debated question as to the University of Siberia, has definitively given the preference to Tomsk, against Omsk. We are glad to learn this result, because of the central position of Tomsk, its larger population, not exclusively administrative, as at Omsk, and the larger number of secondary schools. Several Siberian merchants have endowed the future University with considerable sums of money.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, January 31.—"On the Expression of the Product of any Two Legendre's Coefficients by means of a Series of Legendre's Coefficients," by Prof. J. C. Adams, F.R.S.

Royal Society, February 24.—"On the Use of the Reflection Grating in Eclipse Photography," by J. Norman Lockyer, F.R.S.

The results obtained by the Eclipse Expedition to Siam have led me to think that, possibly, the method of using the coronal atmosphere as a circular slit, suggested by Prof. Young and myself, for the Indian eclipse of 1871, might be applied under very favourable conditions, if the prism or train of prisms hitherto employed were replaced by one of those reflection gratings with which the generosity of Mr. Rutherfurd has endowed so many of our observers.

To test this notion I have made some experiments with a grating, which I owe to Mr. Rutherfurd's kindness, containing 17,280 lines to the inch. The results of these observations I have now the honour of laying before the Royal Society.

In front of the lens of an ordinary electric lamp, which lens was adjusted to throw a parallel beam, I have introduced a circular aperture, cut in cardboard, forming an almost complete ring, some two inches in interior diameter, the breadth of the ring being about $\frac{1}{8}$ inch. This was my artificial eclipse.

At a distance from the lamp of about thirteen yards, I mounted a $3\frac{3}{4}$ inch Cooke telescope, of fifty-four inches focal length. Some distance short of this focus I placed Mr. Rutherfurd's grating, and, where the first order spectrum fell, I placed a focussing screen. To adjust for sharp focus, in the first instance, the grating was so inclined to the axis of the telescope that the image of the ring reflected by the silver surface adjacent to the grating was thrown on to the screen. This done, the grating was placed at right angles to the axis, and the spectrum of the circular slit, illuminated by sodium vapour and carbon vapour, photographed for the first, second, and third orders on one side. The third order spectrum, showing the exquisite rings due to the carbon vapour flutings was produced in forty-two seconds. The first order spectrum, also submitted to the Society, was produced in the same period of time, and was very much over-exposed; it is, therefore, I think not expecting too much that we should be able to take a photograph of the eclipse, in the third order, in two minutes; but let us make it four. Similarly, we may hope for a photograph of the second order in two minutes, and it is, I